Playgrounds

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CHAPTER 3
EFFECTIVENESS OF THE PLAYGROUNDS PROGRAMME ON PA LEVELS DURING RECESS IN 6-YEAR-OLD TO 12-YEAR-OLD CHILDREN

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ABSTRACT

AIMS

Worldwide levels of daily physical activity (PA) in children are low. This has negative health consequences. Schools have been recognised as key settings to promote PA. This study evaluates the effectiveness of the playground programme PLAYgrounds on increasing PA.

METHODS

PLAYgrounds was evaluated by a controlled trial, with a follow-up during one school year (10 months). Accelerometer data were collected on 1500 children in total, divided over 19 sampling moments (every 2 weeks). SOPLAY data were collected at nine sampling moments (once a month). Four intervention and four control schools were matched for playground size, number of pupils and PA levels at baseline. The intervention consisted of restructuring the playground by playground markings and by encouragement of the active use of the playground, through the provision of play equipment and educational measures such as adult encouragement and supporting physical education classes. Multilevel regression analyses were performed to analyse the effects of the intervention.

RESULTS

PA levels in the intervention group (moderate PA) were significantly different ($p<0.001$) from the control group (light PA). During the intervention on an average 77.3% of the children engaged in moderate-to-vigorous physical activity in the intervention group and 38.7% in the control group. The effect of the intervention was significantly stronger for girls than for boys ($p<0.001$).

CONCLUSION

The PLAYgrounds programme was effective in increasing PA levels in children during recess over the course of one school year. Thus, the programme could be used to provide structured PA promotion.

INTRODUCTION

Low physical activity (PA) in children is a cause for concern. On average, globally only 34% of the children between the ages of 4 and 12 years meet the guideline (1) of a minimum of 60 minutes of at least moderate intensity PA per day on each day of the week (2). This is troublesome as physical inactivity is related to a multitude of short-term and long-term negative health consequences in children, such as high-blood cholesterol, high blood pressure, markers of the metabolic syndrome as a cardiometabolic risk, overweight and obesity, low bone density and depression (3). Therefore, promoting daily PA in children is a major public health priority.

Schools have been recognised as key settings for promoting PA, with children spending a large part of their regular days in school (4). Within the school, physical education (PE) lessons and recess represent the two main contexts in which children have the opportunity to be physically active. Pate et al., (5) showed that PA in an organized setting, but where children choose their activities freely to interact with their peers, is the best way to accumulate PA.

During recess children are free to choose their activities. However, social structures such as hierarchy of power based around age provide less play space for the more timid children. Pellegrini and Smith (6) for example, showed that when soccer (which is usually played by the strongest boys) became less dominant, more opportunities were created to be physically active for the other children at the playground. Zask et al., (7) showed that less physically talented children were more likely to participate in PA in schools with a lower number of pupils at the playground (e.g. more play space per child).

Besides restricting activities that dominate the playground to specified areas or allowing fewer children at the same time at the playground, different other approaches have been shown to be effective in increasing PA. These include playground markings (8–10) time-management (11), obstacle courses or fitness breaks (12), equipment provision (13) and increasing the amount of playground facilities (14). Besides such environmental changes, educational or social measures such as supervision and encouragement from adults (15) are also shown to be effective in increasing PA during recess.

However, most studies had a short-term follow-up and evaluated only a single intervention measure. Therefore, we developed the multicomponent PLAYgrounds programme in which different effective components from earlier studies have been compiled. The PLAYgrounds programme consists of a combination of management of the playground environment, and thereby creating a more balanced use of the playground by all children of providing play equipment and of encouragement from adults. The aim of this study was to develop an effective and sustainable programme to encourage PA levels during recess in 6-year-old to 12-year-old children. Therefore, the follow-up was conducted during a whole school year. This paper reports on the effectiveness of the PLAYgrounds programme to encourage PA levels during recess in 6-year-old to 12-year-old children.

METHODS

PARTICIPANTS

In 2009–2010, eight public primary schools (four intervention, four control) consisting of 2310 children of 6-year-old to 12-year-old participated in this prospective controlled trial, with a follow-up of one school year (September-June, 10 months). Intervention and control schools were matched according to the number of pupils (250-450), playground size (600-1200 m2) and baseline playground use, that is, the average

level of energy expenditure at the playground as determined through the SOPLAY observational protocol (16). After matching, schools were randomly allocated to the intervention or control condition.

All schools were located in the urban area of Amsterdam in neighbourhoods with a relatively large part of the population consisting of children of immigrant origin with a low socioeconomic status. Similar to another school-based study (17) parents of the participating children received a passive informed consent form that explained the nature and procedures of the study allowing them to withdraw. The Medical Ethics Committee of the VU University Medical Centre approved the study design, protocols and informed consent procedure (NTR2386).

INTERVENTION

A full description of the intervention has been published previously (18). Briefly, the intervention consisted of restructuring the playground by multi-coloured lines by which specific areas for different activities were created (i.e. a soccer field, a basketball set-shot area, a circle for circular activities, a dance area, a throw and catch area, a skipping area and a bounce area). Through 'hotspots' management (i.e. a place where the majority of children would like to play) all children, including the more timid, were to be able to play at these areas.

In addition, altered recess time management, by using a recess schedule which allowed a maximum of two classes at the playground at the same time, reduced the number of children on the playground at any given time, thus creating more play space per child.

In the Netherlands, recess is a daily 15 minute playtime break in the morning and is embedded in the regular school day. Most children go home for lunch. The intervention focused only on the morning recess and was aimed at increasing the intensity of PA. Increasing the intensity of recess PA could result in recess making a substantial contribution to children's daily PA.

Active usage of the playground was encouraged through the provision of play equipment and monthly themes, and through supervision and encouragement by teachers. The amount of equipment was controlled for by using a standard set of equipment for different age groups, consisting of balls, juggling equipment, ropes, throw and catch equipment and equipment for tag games, crossing games and running games). Each class received a box with play equipment. The regular PE lessons presented ideas on game rules, on how to use the playground, play equipment and the themes that provided a new stimulus every month. All PE teachers received instruction materials and had six meetings with the researcher for training and support. The teachers encouraged the children of their own class during recess, which was a new part of their duty besides the regular supervision and in addition, they were scheduled to participate on the playground together with the children once a week.

DEMOGRAPHIC INFORMATION

The school register provided demographic information (age, gender and ethnicity). Children were classified as being of western or non-western descent following the Dutch Central Bureau for Statistics definition (CBS 2000). A child was classified as non-Western if the child itself or at least one parent was born in Africa, Latin America, Asia (except for Japan and Indonesia) or Turkey.

MEASUREMENTS

Outcome measures of this study were the average level of PA in children during recess expressed in counts/min and in energy expenditure (kcal/kg/min). In addition, the proportion of children who

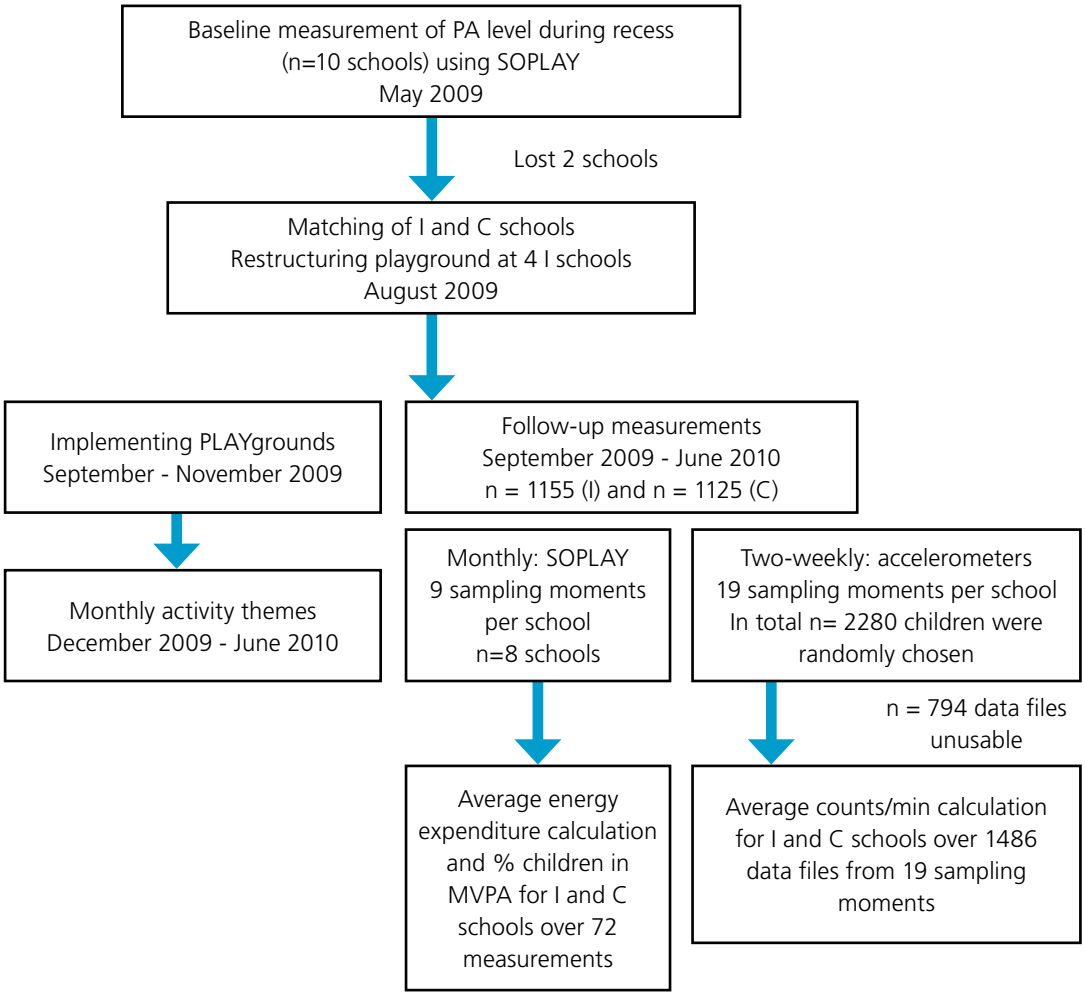

Figure 1: Flowchart of the measurements and intervention. I = intervention schools; C = control schools; n = number; % = percentage of.

were engaged in moderate-to-vigorous physical activity (MVPA) was assessed. Measurements consisted of both objective (accelerometry) and observational (SOPLAY) measures.

Figure 1 shows a flow chart of the measurements and intervention.

ACCELEROMETRY

Each school was visited every 2 weeks on the same day of the week. Accelerometry measurements were conducted during recess, using triaxial accelerometers (ActiGraph, ActiTrainer). In children the validity of the ActiGraph to measure daily levels of PA is moderate-to-good (19, 20).

For our purpose we measured the total number of accelerometer counts during a 15 minute bout of PA in a controlled setting.

At the start of the school year a random sequence was made in which the children were selected to wear the accelerometer following the school register. Per visit a total of 15 children of all ages (2-3 per grade) wore an accelerometer during recess. The accelerometer was securely attached to the children's hip by an elastic waist belt. The epoch length was one second and the display was turned off in order to minimise distraction.
In total, 2280 children were selected to wear the accelerometer during a total of 19 sampling moments at each school. Due to several reasons – for example children being absent on the day of measurement, children who switched schools or because of technical failure – 1486 data files were usable for analyses.
Counts per minute for the middle 12 minutes of the 15 minutes recess were derived and analysed, because after subtracting the time required to walk to and from the playground, an average net time of 12 minutes remained.

The following cut-off points were chosen, because they were the most appropriate for our population: light PA below 2000 counts/min, moderate PA between 2000 and 2999 counts/min (moderate) and vigorous PA over 3000 counts/min (21). These cut-off points correspond with approximately <3, 3–6 and >6 metabolic equivalent of task (METs) (21).

OBSERVATIONS

Once a month, on the same day as the accelerometry measurement, two people observed the school's playground during recess with the validated SOPLAY protocol (16). SOPLAY is a standardized protocol consisting of observations on the quantity of use of the playground in general, type of PA, intensity of PA and aspects related to the physical environment (e.g. weather conditions, provision of playground equipment, accessibility and teacher presence).

Eight students from the Academy for Physical Education were trained to observe together with the researcher (per school one student and the researcher). Training consisted of practising at different playgrounds to get familiar with the SOPLAY protocol and the registration of the different variables (like intensity and type of PA). An inter-observer agreement of 88-96% between the different students and the researcher was obtained after 16 hours of training.

Before each observation, the physical environment aspects were registered. The playground was observed as a whole, every 5 minutes during a recess, from left to right. During the intervention period, a total of nine sampling moments per school were done.

Following the SOPLAY protocol, the number of children that engaged in sedentary, walking and very active behaviour was counted to get a summary score and was then transformed into estimates of energy expenditure (kcal/kg/min), by multiplying these with a constant (sedentary; 0.051 kcal/kg/min walking; 0.096 kcal/kg/min and very active; 0.144 kcal/kg/min). These categories are in agreement with the MET values for sedentary (±3 METs), moderate (±6 METs) and vigorous (±9 METs) PA. The transformation of observational data into energy expenditure provided an average level of energy expenditure during recess. The data were also analysed regarding the proportion of children that were engaged in MVPA by counting the children who were observed to be moderate to vigorous physically active and divided by the total number of children.

STATISTICAL ANALYSES

Baseline measurements were compared using independent t-tests (energy expenditure and age) and Pearson Chi-square (ethnicity and gender) in SPSS V.18.0 (IBM). The effectiveness of the PLAYgrounds intervention was analysed by means of a linear multilevel regression analysis to account for the clustered nature of the data. In the multilevel analysis, a two level structure was considered; that is, children were clustered within schools (accelerometry) and sampling moments were clustered within schools (SOPLAY). Beside a crude analysis, an analysis was performed adjusted for season (categorical, four seasons), gender (dichotomous) and age (categorical, three age groups: 6-8, 9-10 and 11-12 years old). In additional analyses on the accelerometer data it was investigated whether season, gender and age were effect modifiers. All multilevel analyses were performed using MLwiN (V.2.21) and a two-tailed significance level of $p<0.05$ was considered statistically significant for all analyses.

RESULTS

PARTICIPANTS

Descriptive characteristics of the children who participated in this study as well as average PA at the playground at baseline are shown in table 1. At baseline, there were no significant differences between the intervention and the control group. The average level of energy expenditure during recess was 0.075 kcal/kg/min (SD 0.01) for the intervention group and 0.082 kcal/kg/min (SD 0.02) for the control group, which corresponds with, respectively, 4.5 and 5 METs (i.e. light PA). In the intervention group 39.6% of the children were engaged in MVPA and 41.2% in the control group.

Table 1 Baseline characteristics

	Intervention	Control
Number of participants (%)	721 (48.5%)	765
Age, years, mean (SD)	8.6 (1.5)	8.7 (1.5)
Gender, number (%)		
- Boys	404 (56.0%)	424 (55.4%)
- Girls	317	341
Ethnicity, number (%)		
- Western	58 (8.1%)	66 (8.6%)
- Non-Western	663	669
Energy expenditure, kcal/kg/min, mean (SD)	0.075 (0.01)	0.082 (0.02)
Proportion of children in MVPA, %	39.6	41.2

SD = standard deviation

PHYSICAL ACTIVITY

Table 2 shows the average PA levels during the intervention. The average counts/min over the course of one school year in the intervention group was 3924 (SD 466) and in the control group 2178 (SD 738) measured by accelerometers. This corresponds, respectively, with vigorous PA (>6 METs) and moderate PA (3-6 METs). The SOPLAY observations showed that the average amount of energy expenditure at the playground was 0.105 kcal/kg/min (SD 0.01) for the intervention group and 0.074 kcal/kg/min (SD 0.01) for the control group. This corresponds respectively with moderate PA (6 METs) and light PA (4 METs). During the intervention, an average of 77.3% of the children in the intervention group was engaged in MVPA, against 38.7% of the children in the control group.

Table 2 Average PA levels (over a school year) during the intervention, measured by accelerometry (counts/min) and by SOPLAY (energy expenditure and proportion of children in MVPA)

	Intervention	Control
Counts/min, mean (SD)	3924 (466)	2178 (738)
Energy expenditure, kcal/kg/min, mean (SD)	0.105 (0.01)	0.074 (0.01)
Proportion of children in MVPA, %	77.3	38.7

MVPA = moderate-to-vigorous physical activity;
PA = physical activity

Table 3 Effectiveness of the intervention measured by accelerometry and by SOPLAY

Accelerometry	B (95% CI)	p-value
Crude model	1747 (1666 – 1827)	<0.001
Adjusted model[a]	1706 (1642 – 1769)	<0.001
SOPLAY		
Crude model	*0.031 (0.027 – 0.035)*	*<0.001*

[a] *Adjusted for season, gender and age*
B: regression coefficient

Table 3 shows the effectiveness of the intervention. In both the crude and adjusted model the intervention effect was significant (p<0.001). The accelerometer data showed that the intervention effect was stronger for girls (p<0.001, boys as reference) and different for the age groups, with the strongest effect for the oldest age group (10-12 years old (p<0.01, youngest age group as reference). An additional analysis with a three-way interaction between age, gender and intervention showed that the effect was strongest for 10-year-old to 12-year-old girls. The intervention effect also varied through the season, with the strongest effect during summer/autumn (the first season). Figure 2 depicts the intervention effect through the different seasons and the effect separately for boys and girls.

DISCUSSION

Multiple studies have been done to evaluate the effectiveness of playground alterations, playground programmes or playground management changes. Most of these studies have a small sample and/or a short-term follow-up. Therefore, our study evaluated the multi-component PLAYgrounds programme with a follow-up of one school year.
The PLAYgrounds programme was effective in increasing PA intensity level during recess, with a significant difference between the intervention group and the control group (p<0.001). The intervention group was on average moderately physically active as opposed to the control group who was lightly physically active. In the intervention group 77.3% of the children engaged in MVPA as opposed to 38.7% of the children in the control group.

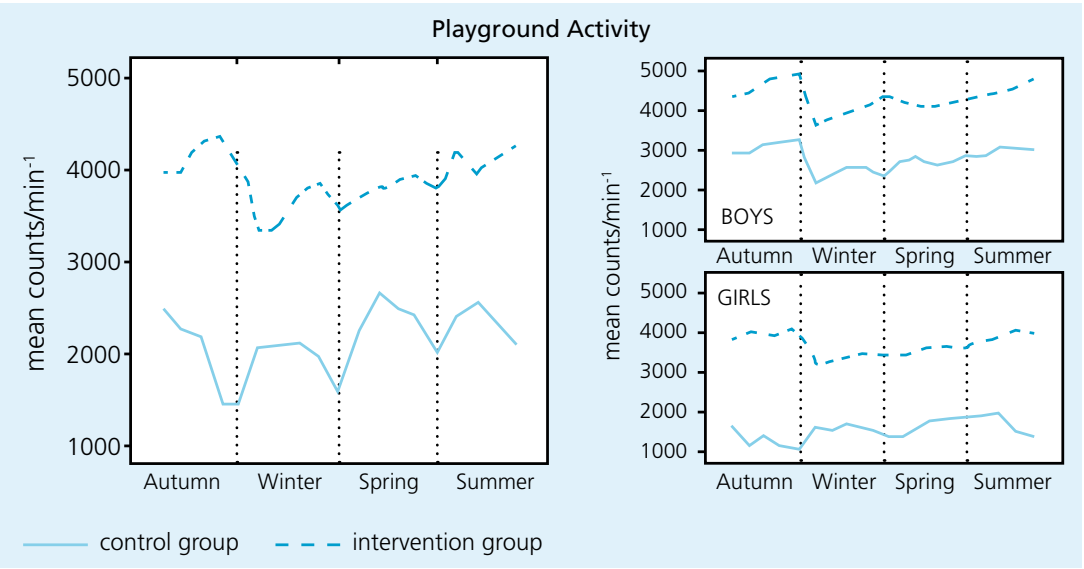

Figure 2: Seasonal fluctuations in physical activity intensity (counts/min) for intervention and control group (A), separately for boys and for girls (B).

Previous playground studies, using measures such as playground markings or equipment provision, were also effective in increasing PA during recess. A review on playground interventions (22) concluded that a number of factors affect children's PA levels during recess, such as playground space or prompts received. However, no studies evaluated the impact all of these factors together. In 2010, a prediction model was made to identify significant variables associated with the level of PA during recess (23). More play space and equipment provision were positive predictors for moderate PA. Our study combined more play space, which was created by restructuring the playground and educational measures, with equipment provision. Besides that, adult supervision and encouragement, as well as playground markings, were part of the PLAYgrounds programme, but these factors were not found to be positive predictors in the prediction model study from 2010. Conversely, these factors were found to have a significant effect in experimental studies (10, 15).

The intervention effect was stronger for girls than for boys, which might be explained by the nature of the intervention programme. The PLAYgrounds programme consisted of different components that appeal to girls in particular (e.g. a designated skipping and dance area). In addition, by creating a specific area for soccer, there was a more balanced partition of the playground among boys and girls. Due to the PLAYgrounds programme, PA levels in especially older girls increased from sedentary to moderate PA. This is quite promising for structured health promotion, since PA levels decrease across adolescence into adulthood (1, 24) and, in general boys, are more active than girls (24).

In most previous studies the largest effect of a playground intervention was at the start of the intervention and it decreased over time (22), which might imply a novelty effect. Our study showed that the PLAYgrounds programme provided a sustained stimulus for increasing recess PA levels during the whole school year, arguably because of monthly motivation with activity themes and PE support. However, a potential seasonal influence was also found. There is some evidence from earlier studies for such a seasonal effect, but most results are contradictory. The prediction model (23) mentioned previously showed a significant negative association between temperature and vigorous activity, but a review (25) showed that seasonal variations suggest higher PA levels during summer months. In our study, the association model was adjusted (among others variables) for season.

The validity and reliability of PA measurements are a general topic of discussion, due to variation in PA duration and PA levels which vary by assessment method (26). An observation method, such as SOPLAY, is subjective and the outcome depends on the researcher's estimation of the intensity of PA. Accelerometers provide an objective measure. On the other hand accelerometry is mostly validated for walking and running activities and the observation method is the most practical method for assessing different kind of activities (e.g. climbing and swinging). In this study both measurement methods were combined and both showed a significant difference between the intervention group and the control group as well as the same seasonal pattern during the school year. However, accelerometer data showed higher PA levels than SOPLAY data. Intensity thresholds for MVPA in youth measured by accelerometry varied widely between studies (27). In our study, cut-off points from Ekelund et al., (21) were chosen to specify the PA level from accelerometer data, because these were most appropriate to the group of participants in our study. With the
SOPLAY method an average energy expenditure of the playground is calculated, which is based on

predefined constants. Due to the variation in intensity thresholds for accelerometers and a different method of defining PA levels by SOPLAY, the results of this study expressed in intensity levels are not in agreement with each other. This makes the interpretation of the results in terms of PA levels ambiguous.

In our study the outcome measure was average PA level during recess. In most studies PA level is measured during a whole day or week and the outcomes are expressed in minutes spent in intensity levels or minutes spent in activities. The primary goal of our intervention was to encourage children to increase their PA levels during a short break. With regard to our intervention it was not important as to what kind of activities they were involved in, as long as they were physically active. In other countries recess lasts longer and children also have a lunch recess, arguably suggesting that the PLAYgrounds intervention which we evaluated could be more effective in school settings with multiple recess break (including lunch) during the school day.

The aim of the study was to increase PA levels and make recess contribute to the recommended daily PA. Following the Dutch Public Health (PH) guideline of minimal daily PA (28) intensity categories are based on <5, 5-8 and >8 METs, respectively, for light, moderate and vigorous PA for youth. For accelerometry, this corresponds with the cut-off points <4100 (light), 4100-8200 (moderate) and >8200 counts/min (vigorous) (29). This means that despite a significant intervention effect, the intensity level at the intervention schools still corresponds with light intensity PA, while the PH guideline recommends at least 1 hour of moderate intensity PA per day. On the other hand, the SOPLAY data showed that the intervention group engaged on average in moderate intensity PA during the intervention. This implies that the PLAYgrounds programme during recess could contribute 25% to the recommended daily PA levels, since recess is 15 min per day. Based on the results of this study, multiple moments of recess during the school day should be recommended to encourage children to be sufficiently physically active every day.

LIMITATIONS

There are several limitations when interpreting the results from this study. First, in the PLAYgrounds programme different factors were combined to stimulate PA during recess, but it is not clear as to which factor or factors contributed more than other factors. Besides that, the educational measures, such as the supporting PE programme as well as the adult supervision or encouragement were dependent on the motivation of the PE teacher and classroom teachers, although the researcher supported the teachers and evaluated the process. Second, a combination of measurement methods was used to evaluate the effect of the intervention. However, the interpretation of the data is still ambiguous when translating them into METs or into the proportional contribution to the PH guideline of required daily PA.

Data on the effectiveness of the intervention were only collected during recess and showed that children were more physically active. It could occur that children compensate this higher level of PA throughout the rest of the day, but since this was not measured, this remains unclear.

CONCLUSION

This study showed that the PLAYgrounds intervention programme, which combined structural playground changes with playground management in primary schools, increased average PA levels during recess along one school year and could be used to provide structured PA promotion.

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